

What is claimed is:

1    1. A communication node comprising:  
2                 an optical signal transceiver having at least one optical  
3         signal transmitting device and at least one optical signal  
4         receiving device to transmit and receive an optical signal to and  
5         from an opposite communication node;  
6                 at least one optical signal transmitting communication line  
7         to transmit an optical signal to said opposite communication node;  
8                 at least one optical signal receiving communication line  
9         to receive an optical signal from said opposite communication  
10      node; and  
11                 a switching device being connected to said optical signal  
12         transmitting device and to said optical signal receiving device  
13         to transmit, when no failure has occurred in said optical signal  
14         transmitting communication line and in said optical signal  
15         receiving communication line, an optical signal fed from said  
16         optical signal transmitting device to said optical signal  
17         transmitting communication line and to transmit an optical signal  
18         fed from said optical signal receiving communication line to said  
19         optical signal receiving device, which does switching, when a  
20         failure has occurred in said optical signal transmitting  
21         communication line, so that said optical signal fed from said  
22         optical signal transmitting device is transmitted to said optical  
23         signal receiving communication line and which does switching,  
24         when a failure has occurred in said optical signal receiving  
25         communication line, so that said optical signal to be fed to said  
26         optical signal receiving device is received from said optical  
27         signal transmitting communication line.

1 2. The communication node according to Claim 1, wherein  
2 wavelengths of optical signals transmitted from all said optical  
3 signal transmitting devices being placed in said optical signal  
4 transceiver are different from one another and from wavelengths  
5 of optical signals transmitted from said opposite communication  
6 node.

1 3. The communication node according to Claim 1, wherein said  
2 switching device includes an optical switch that enables an  
3 optical signal to be transmitted in bidirectional directions.

1 4. A communication node comprising:

2 a plurality of optical signal transceivers each having at  
3 least one optical signal transmitting device and at least one  
4 optical signal receiving device, which transmit and receive an  
5 optical signal to and from an opposite communication node;

6 a plurality of optical signal communication lines to  
7 transmit and receive an optical signal between each of said  
8 optical signal transceivers and said opposite communication node;  
9 and

10 a switching device being connected to said optical signal  
11 transmitting device and to said optical signal receiving device,  
12 which does switching, when a failure has occurred in any of said  
13 plurality of said optical signal communication line, so that an  
14 optical signal that had been transmitted through said optical  
15 signal communication line is transmitted in a multiplexed manner  
16 through any other optical signal communication line.

1 5. The communication node according to Claim 4, wherein a

2 wavelength of an optical signal that had been transmitted through  
3 an optical signal communication line in which a failure occurred  
4 is different from a wavelength of an optical signal that is  
5 transmitted through an optical signal communication line in which  
6 said optical signal is transmitted in a multiplexed manner when  
7 a failure occurs in said optical signal communication line.

1 6. The communication node according to Claim 4, wherein said  
2 switching device includes an optical switch that enables an  
3 optical signal to be transmitted in bidirectional directions.

1 7. A communication node being used in a ring-type network in  
2 which a plurality of said communication nodes is connected,  
3 comprising:

4 an optical signal transceiver having at least one optical  
5 signal transmitting device and at least one optical signal  
6 receiving device to receive an optical signal from one adjacent  
7 communication node and to transmit said optical signal to an other  
8 adjacent communication node; and

9 a switching device being connected to one optical signal  
10 communication line connected to said one adjacent communication  
11 node, to an other optical signal communication line connected to  
12 said other adjacent communication node, to said optical signal  
13 transmitting device and to said optical signal receiving device,  
14 which receives, when no failure has occurred in said one optical  
15 signal communication line and in said other optical signal  
16 communication line, an optical signal sent from said one adjacent  
17 communication node from said one optical signal communication  
18 line and transmits it to said optical signal receiving device and

19 transmits an optical signal to be transferred from said optical  
20 signal transmitting device to said other adjacent communication  
21 node to said other optical signal communication line and relays  
22 an optical signal, when an optical signal fed from a communication  
23 node other than said one adjacent communication node making up  
24 said ring-type network is input from said other optical signal  
25 communication line to transfer it to said one optical signal  
26 communication line and which does switching, when the failure has  
27 occurred in said one optical signal communication line, so that  
28 said optical signal fed from said one adjacent communication node  
29 is received from said other optical signal communication line and  
30 is transmitted to said optical signal receiving device and does  
31 switching, when the failure has occurred in said other optical  
32 signal communication line, so that said optical signal to be  
33 transferred from said optical signal transmitting device to said  
34 other adjacent communication node is transmitted to said one  
35 optical signal communication line.

1 8. The communication node according to Claim 7, wherein  
2 wavelengths of optical signals transmitted by all communication  
3 nodes making up said ring-type network are different from one  
4 another.

1 9. The communication node according to Claim 7, wherein said  
2 switching device includes an optical switch that enables an  
3 optical signal to be transmitted in bidirectional directions.

1 10. A communication node being used in a ring-type network in  
2 which a plurality of communication nodes is connected,

3 comprising:

4           an optical signal transceiver having a plurality of optical  
5 signal transmitting devices to transmit an optical signal to an  
6 adjacent communication node and a plurality of optical signal  
7 receiving devices to receive an optical signal from said adjacent  
8 communication node and to transmit and receive optical signals  
9 to and from both of said adjacent communication node;

10           an optical signal transmitting communication line to  
11 transmit an optical signal to said adjacent communication node;

12           an optical signal receiving communication line to receive  
13 an optical signal from said adjacent communication node;

14           a switching device being connected to said optical signal  
15 transmitting device and to said optical signal receiving device,  
16 which transmits, when no failure has occurred in said optical  
17 signal transmitting communication line and in said optical signal  
18 receiving communication line, an optical signal to be transferred  
19 from said optical signal transmitting device to said adjacent  
20 communication node to said optical signal transmitting  
21 communication line and receives an optical signal sent from said  
22 adjacent communication node from said optical signal receiving  
23 communication line and transmits it to said optical signal  
24 receiving device and which does switching, when a failure has  
25 occurred in said optical signal transmitting communication line,  
26 so that an optical signal that had been transmitted from said  
27 optical signal transmitting device to said optical signal  
28 transmitting communication line is transmitted to said optical  
29 signal receiving communication line being connected similarly to  
30 said adjacent communication node to which said optical signal  
31 transmitting communication line had been connected and does

32 switching, when a failure has occurred in said optical signal  
33 receiving communication line, so that an optical signal that had  
34 been received from said optical signal receiving communication  
35 line and had been transmitted to said optical signal receiving  
36 device is received from an optical signal transmitting  
37 communication line being connected similarly to said adjacent  
38 communication node to which said optical signal receiving  
39 communication line had been connected.

1 11. The communication node according to Claim 10, wherein  
2 wavelengths of optical signals to be transmitted from said optical  
3 signal transmitting device to said adjacent communication node  
4 are different from those of optical signals fed from said adjacent  
5 communication node.

1 12. The communication node according to Claim 10, wherein said  
2 switching device includes an optical switch that enables an  
3 optical signal to be transmitted in bidirectional directions.

1 13. A switching device being connected to an optical signal  
2 transceiver comprising at least one optical signal transmitting  
3 device and at least one optical signal receiving device to  
4 transmit and receive an optical signal to and from an opposite  
5 communication node and making up a communication node with said  
6 optical signal transceiver,

7           said switching device configured to be connected to at least  
8 one piece of an optical signal transmitting communication line  
9 to transmit an optical signal to said opposite communication node,  
10 at least one piece of an optical signal receiving communication

11 line to receive an optical signal from said opposite communication  
12 node, said optical signal transmitting device and said optical  
13 signal receiving device; and

14 wherein, when no failure has occurred in said optical signal  
15 transmitting communication line and in said optical signal  
16 receiving communication line, an optical signal fed from said  
17 optical signal transmitting device is transmitted to said optical  
18 signal transmitting communication line and an optical signal fed  
19 from said optical signal receiving communication line is  
20 transmitted to said optical signal receiving device and wherein,  
21 when a failure has occurred in said optical signal transmitting  
22 communication line, switching is done so that said optical signal  
23 fed from said optical signal transmitting device is transmitted  
24 to said optical signal receiving communication line and, when a  
25 failure has occurred in said optical signal receiving  
26 communication line, switching is done so that said optical signal  
27 to be fed to said optical signal receiving device is received from  
28 said optical signal transmitting communication line.

1 14. The switching device according to Claim 13, wherein  
2 wavelengths of optical signals fed from all of said optical signal  
3 transmitting devices being placed in said optical signal  
4 transceiver are different from one another and from those of  
5 optical signals transmitted from said opposite communication  
6 node.

1 15. The switching device according to Claim 13, further  
2 comprising an optical switch that enables an optical signal to  
3 be transmitted in bidirectional directions.

1   16. A switching device being connected to a plurality of optical  
2   signal transceivers each having at least one optical signal  
3   transmitting device and at least one optical signal receiving  
4   device to transmit and receive an optical signal to and from an  
5   opposite communication node and making up a communication node  
6   with said plurality of optical signal transceivers,

7                 said switching device configured to be connected to a  
8   plurality of optical signal communication lines to transmit and  
9   receive an optical signal between said optical signal  
10   transmitting device and said opposite communication node, each  
11   said optical signal transmitting device, and each said optical  
12   signal receiving device,

13                 wherein switching is done, when a failure occurs in any of  
14   said optical signal communication lines, so that an optical signal  
15   that had been transmitted through said optical signal  
16   communication line in which said failure has occurred is  
17   transmitted in a multiplexed manner through any other optical  
18   signal communication lines.

1   17. The switching device according to Claim 16, wherein  
2   wavelengths of optical signals that had been transmitted through  
3   an optical signal communication line in which a failure has  
4   occurred are different from those of optical signals that are  
5   transmitted through an optical signal communication line in which  
6   said optical signals are transmitted in a multiplexing manner when  
7   said failure has occurred in said optical signal communication  
8   line.

1   18. The switching device according to Claim 16, further

2 comprising an optical switch that enables an optical signal to  
3 be transmitted in bidirectional directions.

1 19. A switching device being connected to an optical signal  
2 transceiver having at least one optical signal transmitting  
3 device and at least one optical signal receiving device and  
4 receiving an optical signal from one adjacent communication node  
5 and transmitting an optical signal to an other adjacent  
6 communication node and making up a communication node of a  
7 ring-type network, said switching device configured to be  
8 connected one optical signal communication line connected to said  
9 one adjacent communication node, to an other optical signal  
10 communication line connected to said other adjacent communication  
11 node, to said optical signal transmitting device and to said  
12 optical signal receiving device,

13 wherein, when no failure has occurred in said one optical  
14 signal communication line and in said other optical signal  
15 communication line, an optical signal fed from said one adjacent  
16 communication node is received from said one optical signal  
17 communication line and is transmitted to said optical signal  
18 receiving device and an optical signal to be transferred from said  
19 optical signal transmitting device to said other adjacent  
20 communication node is transmitted to said other optical signal  
21 communication line and, when an optical signal fed from a  
22 communication node other than said one adjacent communication  
23 node making up said ring-type network is input from said adjacent  
24 optical signal communication line, said optical signal is relayed  
25 to transfer it to said one optical signal communication line and  
26 switching is done, when a failure occurs in said one optical signal

27 communication line, so that said optical signal fed from said one  
28 adjacent communication node is received through said other  
29 optical signal communication line and is transmitted to said  
30 optical signal receiving device and, when a failure has occurred  
31 in said other optical signal communication line, an optical signal  
32 to be transferred from said optical signal transmitting device  
33 to said other adjacent communication node is transmitted to said  
34 one optical signal communication line.

1 20. The switching device according to Claim 19, wherein  
2 wavelengths of optical signals to be transmitted by all  
3 communication nodes making up said ring-type network are  
4 different from one another.

1 21. The switching device according to Claim 19, further  
2 comprising an optical switch that enables an optical signal to  
3 be transmitted in bidirectional directions.

1 22. The switching device being connected to an optical signal  
2 transceiver having a plurality of optical signal transmitting  
3 devices to transmit an optical signal to adjacent communication  
4 nodes and a plurality of optical signal receiving devices to  
5 receive an optical signal from said adjacent communication nodes  
6 and to transmit and receive an optical signal to and from both  
7 of said adjacent communication nodes and making up a communication  
8 node of a ring-type network,

9           said switching device configured to be connected to an  
10 optical signal transmitting communication line to transmit an

11 optical signal to said adjacent communication node, an optical  
12 signal receiving communication line to receive an optical signal  
13 from said adjacent communication node, said plurality of said  
14 optical signal transmitting devices and said plurality of said  
15 optical signal receiving devices,

16 wherein no failure has occurred in said optical signal  
17 transmitting communication line and in said optical signal  
18 receiving communication line, an optical signal to be transferred  
19 from said optical signal transmitting device to said adjacent  
20 communication node is transmitted to said optical signal  
21 transmitting communication line and an optical signal fed from  
22 said adjacent communication node is received from said optical  
23 signal receiving communication line and is transmitted to said  
24 optical signal receiving device and, when a failure has occurred  
25 in said optical signal transmitting communication line, switching  
26 is done so that an optical signal that had been transmitted from  
27 said optical signal transmitting device to said optical signal  
28 transmitting communication line is transmitted to an optical  
29 signal receiving communication line being connected similarly to  
30 said adjacent communication node to which said optical signal  
31 transmitting communication line had been connected and when a  
32 failure has occurred in said optical signal receiving  
33 communication line, switching is done so that an optical signal  
34 that had been received from said optical signal receiving  
35 communication line and transmitted to said optical signal  
36 receiving device is received from an optical signal transmitting  
37 communication line being connected similarly to said adjacent  
38 communication node to which said optical signal receiving  
39 communication line had been connected.

1   23. The switching device according to Claim 22, wherein  
2   wavelengths of optical signals to be transmitted from said optical  
3   signal transmitting device to said adjacent communication node  
4   are different from those of optical signals fed from said adjacent  
5   communication node.

1   24. The switching device according to Claim 22, further  
2   comprising an optical switch that enables an optical signal to  
3   be transmitted in bidirectional directions.

1   25. A switching device for transmitting a plurality of external  
2   optical signals through a plurality of optical signal  
3   communication lines, comprising:

4                 a plurality of optical multiplexing and demultiplexing  
5   devices each being placed so as to correspond to said optical  
6   signal communication line and having a plurality of first input  
7   and output ports and one second input and output ports, which  
8   allows optical signals being different from one another to be  
9   transmitted between each of said first input and output ports and  
10   said second input and output ports and has said second input and  
11   output ports be connected to an optical signal communication line  
12   being corresponded to said optical multiplexing and  
13   demultiplexing device; and

14                 a plurality of optical switches being placed so as to  
15   correspond to said external optical signal, which allows an  
16   external optical signal being corresponding to each of said  
17   optical switches to be input to said first input and output port  
18   of said optical multiplexing and demultiplexing device when no  
19   failure has occurred in an optical signal communication line

20 corresponding to a specified optical multiplexing and  
21 demultiplexing device and which does switching, when a failure  
22 has occurred in said optical signal communication line, so that  
23 said external optical signal is input to a first input and output  
24 port of an other multiplexing and demultiplexing device.

1 26. The switching device according to Claim 25, wherein a  
2 plurality of said first input and output ports of said plurality  
3 of said optical multiplexing and demultiplexing devices allow  
4 optical signal having wavelengths being different from one  
5 another to be transmitted.

1 27. A switching device for transmitting a plurality of external  
2 optical signals through a plurality of optical signal  
3 communication lines comprising:

4 a plurality of first optical multiplexing and  
5 demultiplexing devices each being placed so as to correspond to  
6 said optical signal communication line and having a plurality of  
7 first input and output ports and one second input and output ports,  
8 which allows optical signals being different from one another to  
9 be transmitted between each of said first input and output ports  
10 and said second input and output ports and has each of said second  
11 input and output ports be connected to an optical signal  
12 communication line being corresponded to each of said optical  
13 multiplexing and demultiplexing devices;

14 a plurality of second optical multiplexing and  
15 demultiplexing devices each having a plurality of third input and  
16 output ports and one fourth input and output port, which allows  
17 optical signals being different from one another to be transmitted

18 between each of said third input and output ports and said fourth  
19 input and output ports, each of said third input and output ports  
20 being connected to each of a plurality of external optical signals  
21 input and output ports being different from one another; and  
22 an optical switch being placed so as to correspond to each  
23 of said second optical multiplexing and demultiplexing devices,  
24 which has a fourth input and output port of a second optical  
25 multiplexing and demultiplexing device being corresponded to said  
26 optical switch be connected to a first input and output port of  
27 said first optical multiplexing and demultiplexing device when  
28 no failure has occurred in an optical signal communication line  
29 corresponding to a specified first optical multiplexing and  
30 demultiplexing device and does switching so that a fourth input  
31 and output port of said second optical multiplexing and  
32 demultiplexing device is connected to a first input and output  
33 port of other first optical multiplexing and demultiplexing  
34 device when a failure has occurred in said optical signal  
35 communication line.

1 28. The switching device according to Claim 27, wherein said  
2 plurality of said first input and output ports of said first  
3 optical multiplexing and demultiplexing device allows optical  
4 signals having wavelengths being different from one another to  
5 be transmitted and a plurality of said third input and output ports  
6 of said second optical multiplexing and demultiplexing device  
7 allows optical signals having wavelengths being different from  
8 one another to be transmitted.

1 29. A switching device being connected between two optical

2 signal communication lines making up a ring-type network for  
3 transmitting an external optical signal through said ring-type  
4 network, comprising:

5 two optical multiplexing and demultiplexing devices each  
6 being placed so as to correspond to each of said optical signal  
7 communication lines and having a plurality of first input and  
8 output ports and one second input and output port, which allows  
9 optical signals being different from one another to be transmitted  
10 between each of said first input and output port and said second  
11 input and output port and has an optical signal communication line  
12 corresponding to each of said optical multiplexing and  
13 demultiplexing devices be connected to said second input and  
14 output port and has part of said first input and output ports be  
15 connected to one another; and

16 a plurality of optical switches each being placed so as to  
17 correspond to said external optical signal, which has, when no  
18 failure has occurred in an optical signal communication line being  
19 connected to an optical multiplexing and demultiplexing device  
20 corresponding to a specified optical signal communication line,  
21 an external optical signal being corresponded to each of said  
22 optical switches be input to a first input and output port of each  
23 of said optical multiplexing and demultiplexing devices and does  
24 switching, when a failure has occurred in said optical signal  
25 communication line, so that said external optical signal is input  
26 to a first input and output port of each of said optical  
27 multiplexing and demultiplexing devices corresponding to an other  
28 one optical signal communication line.

1 30. The switching device according to Claim 29, wherein a

2 plurality of said first input and output ports of said plurality  
3 of said optical multiplexing and demultiplexing devices allow  
4 optical signal having wavelengths being different from one  
5 another to be transmitted.

1 31. A switching device for transmitting an external optical  
2 signal through a ring-type network in which a plurality of optical  
3 signal communication lines are connected between adjacent  
4 communication nodes, comprising:

5 a plurality of optical multiplexing and demultiplexing  
6 devices each being placed so as to correspond to each of said  
7 optical signal communication lines and having a plurality of first  
8 input and output ports and one second input and output ports, which  
9 allows optical signals being different from one another to be  
10 transmitted between each of said first input and output ports and  
11 said second input and output ports and has an optical signal  
12 communication line corresponding to each of said optical  
13 multiplexing and demultiplexing devices be connected to said  
14 second input and output port; and

15 a plurality of optical switches each being placed so as to  
16 correspond to said external optical signal, which has, when no  
17 failure has occurred in an optical signal communication line  
18 corresponding to a specified optical multiplexing and  
19 demultiplexing device, an external optical signal corresponding  
20 to each of said optical switches be connected to a first input  
21 and output port of each of said optical multiplexing and  
22 demultiplexing devices and does switching, when a failure has  
23 occurred in said optical signal communication line, so that said  
24 external optical signal be input to a first input and output port

25 of other optical multiplexing and demultiplexing devices.

1 32. The switching device according to Claim 31, wherein a  
2 plurality of said first input and output ports of said plurality  
3 of said optical multiplexing and demultiplexing devices allow  
4 optical signal having wavelengths being different from one  
5 another to be transmitted.